

ELECTRIC FIELD MEASUREMENT IN A DIELECTRIC BARRIER DISCHARGE IN HELIUM AND HELIUM-HYDROGEN MIXTURES

Obradović B. M.,* Ivković S.S., and Kuraica M. M.

Faculty of Physics, University of Belgrade, PO box 368, 11000 Belgrade, Serbia

Abstract.

A classical emission spectroscopy technique, based on the application of the polarization-dependent Stark splitting and shifting of helium line, He I 492.19 nm, and its forbidden component, is used for electric field measurements in the cathode sheet of DBD in helium and helium-hydrogen mixture. Electric field distributions obtained for 200 mbar and 800 mbar pressures showed that electric field linearly decreases in the cathode sheet region of DBD, what is a typical characteristic of the glow discharge. Using linear fits for the electric field distributions it was concluded that the length of the cathode fall region is shorter for helium-hydrogen discharge than for helium discharge at both pressures.

1. INTRODUCTION

The dielectric barrier discharge DBD is one of the plasma sources at high pressure widely applied in plasma chemistry, surface modification, and thin film deposition. It is a low frequency ac discharge in a narrow gap between two electrodes of sufficiently large area covered by a dielectric barrier. Various configurations of electrodes are used in the barrier discharge; the plane configuration is most simple and suitable for experimental investigation and theoretical description. At certain conditions, this discharge is homogeneous in the electrode plane. The homogeneous barrier discharge is very suitable for applications in plasma technologies, especially in surface treatment. It has become the object of intensive experimental and theoretical investigations [1-3]. The homogeneous barrier discharge in helium is characterized by the narrow current pulses of large (tens of milliamperes) amplitude; there is only one pulse per half-cycle of the external voltage. In this mode of the discharge, the spatial structure containing the cathode fall, Faraday dark space, and positive column, develop in the phase of maximal current [1]. This circumstance allowed referring to this mode of the discharge as the atmospheric pressure glow discharge. The cathode fall is responsible for the maintenance of the discharge by extracting electrons from the cathode. Therefore, understanding its characteristics is of vital importance for understanding gas discharge phenomena and their practical applications. In the past, several experimental techniques were developed for determination of electric field strength in the cathode sheath region of glow discharges in helium at low pressures. Most of them are based on the influence of electric field on Stark splitting and/or broadening of laser induced high Rydberg states of helium [4-10]. There is also a classical emission spectroscopy technique based on the application of the polarization-dependent Stark splitting and shifting of visible helium lines and their forbidden components for electric field measurements [11,12]. Following the method demonstrated in [11], the electric field strength, in the cathode sheet of DBD in helium, was determined by using the Stark splitting of He I 447.15 nm and He I 492.19 nm lines polarized in electric field direction [13]. In this we present new results of electric field measurements in helium and in helium-hydrogen mixture in DBD obtained at 200 and 800 mbar pressure and compared obtained lengths of cathode fall regions.